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(54) **SYSTEM AND METHOD FOR TRACKING AND MONITORING PRISONERS USING IMPULSE RADIO TECHNOLOGY**

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(58) **Field of Search** 340/573.1, 573.3, 340/573.4, 573.7, 539, 572.8, 572.9, 991

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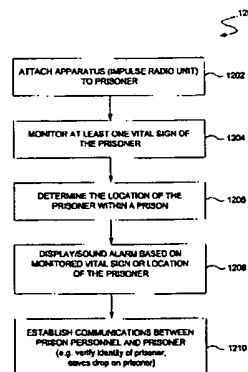
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(57) ABSTRACT

A system, apparatus and method are provided that utilize the communication capabilities and positioning capabilities of impulse radio technology to overcome the shortcomings in conventional prison monitoring systems. Basically, the present invention enables prison personnel to track the movements of a prisoner and/or monitor the vital signs of a prisoner using impulse radio technology that is well suited for a prison environment.

26 Claims, 19 Drawing Sheets



Antennae Architectures

Referring to FIG. 21, there is illustrated a diagram of a steerable null antennae architecture capable of being used in an impulse radio positioning network. The aforementioned impulse radio positioning networks can implement and use steerable null antennae to help improve the impulse radio distance calculations. For instance, all of the reference impulse radio units R1-R4 or some of them can utilize steerable null antenna designs to direct the impulse propagation; with one important advantage being the possibility of using fewer reference impulse radio units or improving range and power requirements. The mobile apparatus A1 can also incorporate and use a steerable null antenna.

Referring to FIG. 22, there is illustrated a diagram of a specialized difference antennae architecture capable of being used in an impulse radio positioning network. The reference impulse radio units R1-R4 of this architecture may use a difference antenna analogous to the phase difference antenna used in GPS carrier phase surveying. The reference impulse radio units R1-R4 should be time synched and the mobile apparatus A1 should be able to transmit and receive.

Referring to FIG. 23, there is illustrated a diagram of a specialized directional antennae architecture capable of being used in an impulse radio positioning network. As with the steerable null antennae design, the implementation of this architecture is often driven by design requirements. The reference impulse radio units R1-R4 and the mobile apparatus A1 can incorporate a directional antennae. In addition, the reference impulse radio units R1-R4 are likely time-synched.

Referring to FIG. 24, there is illustrated a diagram of an amplitude sensing architecture capable of being used in an impulse radio positioning network. Herein, the reference impulse radio units R1-R4 are likely time-synched. Instead of the mobile apparatus A1 and reference impulse radio units R1-R2 measuring range using TOA methods (round-trip pulse intervals), signal amplitude is used to determine range. Several implementations can be used such as measuring the "absolute" amplitude and using a pre-defined look up table that relates range to "amplitude" amplitude, or "relative" amplitude where pulse amplitudes from separate radios are differenced. Again, it should be noted that in this, as all architectures, the number of radios is for illustrative purposes only and more than one mobile impulse radio can be implemented in the present architecture.

From the foregoing, it can be readily appreciated by those skilled in the art that the present invention provides a system, apparatus and method for tracking the location of a prisoner and/or monitoring the vital signs of the prisoner. Also, the present invention enables prison personnel to communicate with or eavesdrop on a prisoner.

Although various embodiments of the present invention have been illustrated in the accompanying Drawings and described in the foregoing Detailed Description, it should be understood that the invention is not limited to the embodiments disclosed, but is capable of numerous rearrangements, modifications and substitutions without departing from the spirit of the invention as set forth and defined by the following claims.

What is claimed is:

1. A method for tracking and monitoring a prisoner, said method comprising the steps of:

attaching an ultra wideband impulse radio unit to the prisoner;

determining a position of the prisoner from the interaction between the ultra wideband impulse radio unit and at

least two of a plurality of reference ultra wideband impulse radio units distributed at known locations throughout a prison;

receiving, at a central station, information from the ultra wideband impulse radio unit relating to the prisoner;

displaying, at the central station, at least a portion of the information relating to the prisoner including the position of the prisoner within the prison; and

using the ultra wideband impulse radio unit and another ultra wideband impulse radio unit at the central station to establish two-way communications between prison personnel at the central station and the prisoner, wherein the ultra wideband impulse radio unit is used to determine the position of the prisoner and also used to establish the two-way communications between the prison personnel and the prisoner.

2. The method of claim 1, wherein the information relating to the prisoner includes a vital sign of the prisoner.

3. The method of claim 2, further comprising the step of tracking the prisoner within a prison.

4. The method of claim 1, wherein said step of displaying further includes indicating an alarm whenever the prisoner roams outside of an authorized location.

5. The method of claim 1, wherein said step of displaying further includes indicating an alarm whenever the prisoner tampers with the ultra wideband impulse radio unit.

6. The method of claim 1, wherein at least one of said reference ultra wideband impulse radio units further supports an ultra wideband impulse radar operation which enables the at least one reference ultra wideband impulse radio unit to sense the movement of another person not carrying an ultra wideband impulse radio unit within the prison.

7. The method of claim 1, wherein said step of using further includes enabling the prison personnel using the central station to eavesdrop on the prisoner.

8. The method of claim 1, wherein said step of using further includes enabling the prison personnel using the central station to notify the prisoner using the ultra wideband impulse radio unit that a rule has been violated.

9. The method of claim 1, wherein said step of using further includes enabling the prison personnel using the central station to verify the identity of the prisoner using voice recognition technology.

10. The method of claim 1, further comprising the step of coupling a sensor to the ultra wideband impulse radio unit, wherein the sensor is capable of monitoring at least one vital sign of the prisoner.

11. The method of claim 1, wherein said prison personnel using a mobile ultra wideband impulse radio unit can interact with other prison personnel using the central station.

12. A system, comprising:

an ultra wideband impulse radio unit, attached to a prisoner, capable of transmitting a signal containing information relating to the prisoner;

a plurality of reference ultra wideband impulse radio units distributed at known locations throughout a prison at least two of which interact with the ultra wideband impulse radio unit to enable the determination of a position of the prisoner;

a central station capable of obtaining the information and further capable of displaying at least a portion of the information relating to the prisoner including the position of the prisoner within the prison; and

said central station including an ultra wideband impulse radio unit that interacts with the ultra wideband impulse

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radio unit attached to the prisoner to establish two-way communications between prison personnel at the central station and the prisoner, wherein the ultra wideband impulse radio unit attached to the prisoner is used to determine the position of the prisoner and also used to establish the two-way communications between the prison personnel and the prisoner.

13. The system of claim 12, further comprising a sensor, coupled to the ultra wideband impulse radio unit, capable of monitoring at least one vital sign of the prisoner.

14. The system of claim 12, wherein said central station is further capable of indicating an alarm whenever the prisoner roams outside of an authorized location.

15. The system of claim 12, wherein said central station is further capable of indicating an alarm whenever the prisoner tampers with the ultra wideband impulse radio unit.

16. The system of claim 12, wherein at least one of said reference ultra wideband impulse radio units further supports an ultra wideband impulse radar operation which enables the at least one reference ultra wideband impulse radio unit to sense the movement of another person not carrying an ultra wideband impulse radio unit within the prison.

17. The system of claim 12, wherein prison personnel using the central station are capable of eavesdropping on the prisoner.

18. The system of claim 12, wherein prison personnel using the central station are capable of notifying the prisoner that a rule has been violated.

19. The system of claim 12, wherein prison personnel using the central station are capable of verifying the identity of the prisoner using voice recognition technology.

20. The system of claim 12, wherein said prison personnel using a mobile ultra wideband impulse radio unit can interact with the central station.

21. An apparatus comprising:

a fastening mechanism operable to attach said apparatus to a prisoner;

an ultra wideband impulse radio unit, coupled to said fastening mechanism, operable to interact with a plurality of reference ultra wideband impulse radio units such that prison personnel can track a position of the prisoner, wherein the position of the prisoner is determined by:

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synchronizing the reference ultra wideband impulse radio units;

synchronizing the ultra wideband impulse radio unit to the synchronized reference ultra wideband impulse radio units;

collecting and time-tagging range measurements between the ultra wideband impulse radio unit and at

least two of the reference ultra wideband impulse radio units; and

calculating the position of the prisoner within a prison carrying the electronic monitor containing the ultra wideband impulse radio unit using the collected and time-tagged range measurements; and

an interface unit operatively coupled to said wideband impulse radio unit which interacts with a remote central station including an ultra wideband impulse radio unit to establish two-way communications between prison personnel at the central station and the prisoner, wherein the ultra wideband impulse radio unit attached to the prisoner is used to determine the position of the prisoner and also used to establish the two-way communications between the prison personnel and the prisoner.

22. The apparatus of claim 21, further comprising a sensor, coupled to said ultra wideband impulse radio unit, operable to monitor at least one vital sign of the prisoner.

23. The apparatus of claim 21, further comprising an interface unit operable to sound an alarm whenever the prisoner roams outside of an authorized location.

24. The apparatus of claim 21, wherein said interface unit is operable to sound an alarm whenever the prisoner tampers with the apparatus.

25. The apparatus of claim 21, wherein said interface unit enables prison personnel to eavesdrop on the prisoner.

26. The apparatus of claim 21, wherein said interface unit enables prison personnel to verify the identity of the prisoner using voice recognition technology.

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